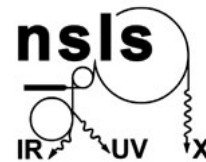


X-ray Tunnel Hazard Awareness

(Course # LS-RAD-XRAYTUN, Rev. 6-6-05)



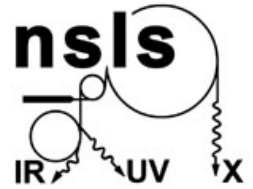
INSTRUCTIONS:

There are 31 screens of information.

On the last screen, you will be asked to print out a PDF file, sign it, and send it in for course credit.

You may come back and refer to this presentation at any time, but please be sure to get course credit the first time you see it.

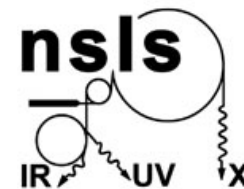
Scope and Purpose



This training provides information to workers entering the NSLS X-ray tunnel so they they may understand which components may still be energized and take appropriate precautions. It should be used as a guide so that they are more aware of their surroundings.

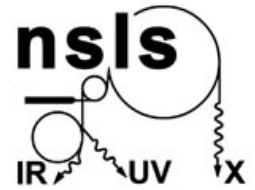
This document is not all inclusive and the potential always exists for changes that are not included herein.

Potential Concerns



- Radiation
 - Exposure
 - Activation
- Lead
- Mechanical Hazards
 - Pressurized Systems
 - Vacuum Systems
 - Movement of Apparatus
 - Climbing
 - Sharp objects
- Electrical
 - Electrical Shock
 - Arc Flash
- Temperature
- Tunnel search and emergency stops
- Magnetic Fields
- RF Fields
- Other
 - Slips, trips, and falls

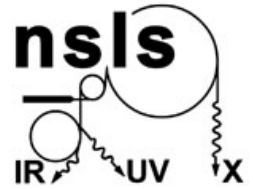
Radiation Hazards



- X-Ray Tunnel Entrance - avoid or minimize time in yellow lined area during booster operations. Local audible and visual alarms will indicate operations.



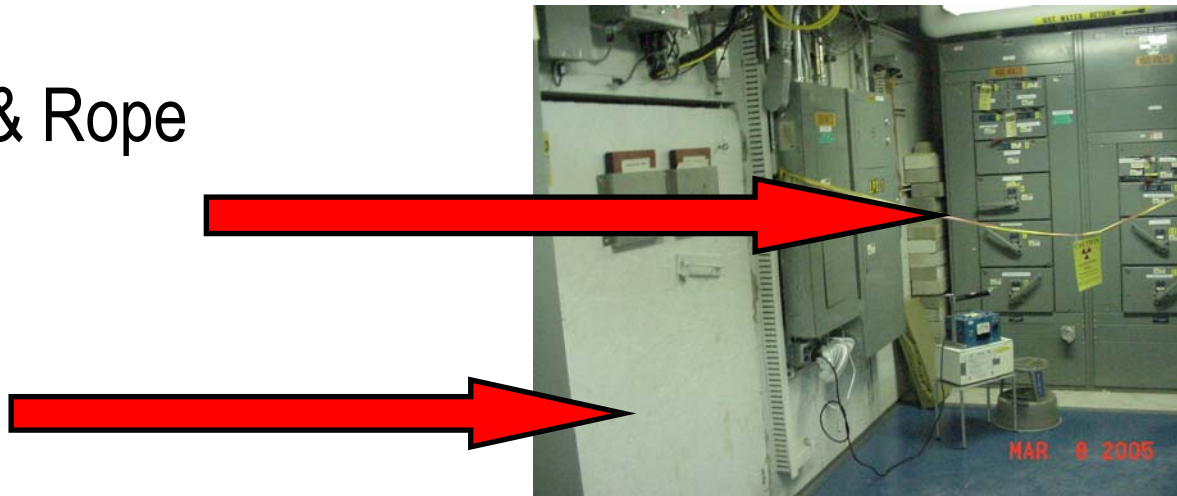
Radiation Hazards



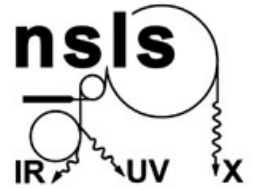
- Outside Ring X-1 and 2 roped off area.
 - Particularly if the access door is opened.

Posting & Rope

Door

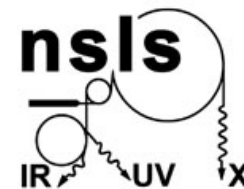


Activation Hazards

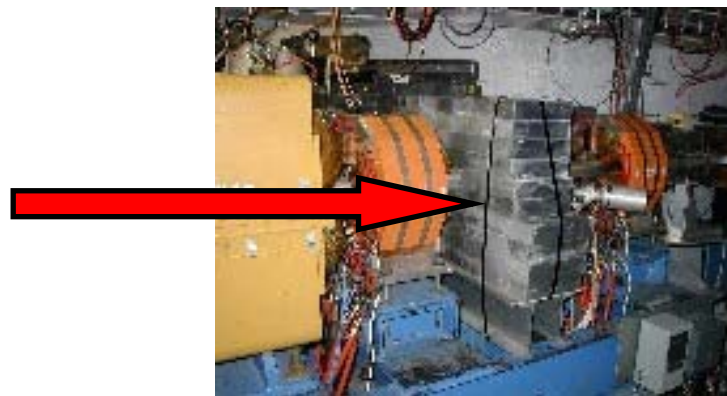
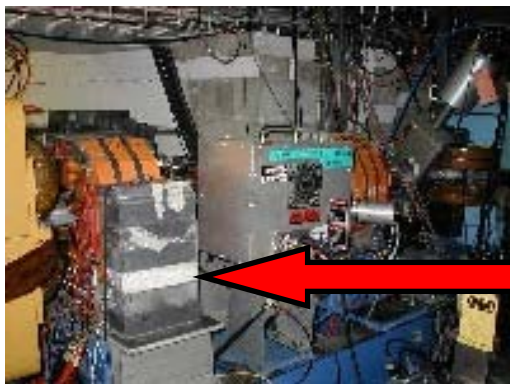


- Any metal that is a part of, or directly attached to, the beam pipe must be checked for radioactivity before leaving the area. There is a table set up outside the ring where items should be left until checked.

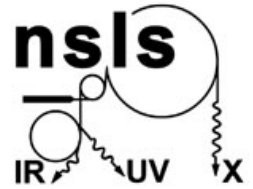
X-Ray Ring Lead Shielding



- Lead is stacked differently throughout the tunnel.
- Heavy lead shielding can pose a potential energy hazard if falling; oxidized lead can also pose a potential breathing hazard when lead is disturbed.
- Lead cannot be moved without the appropriate permits.

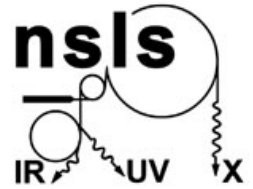


Mechanical Hazards



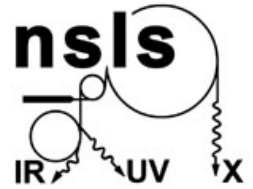
- Pressurized Water
 - HPC - Magnets water cooled; system designed for 225 psig @ 100°F
 - LPC - Supply to Rf Cavities; system designed for 225 psig @ 100°F
 - ALU - Aluminum chamber; system designed for 200 psig @ 100°F
 - EXP - Supplied to X-5 magnets; system designed for 325 psig @ 150°F
- All Water systems are normally closed loop so it takes a pressure boundary failure or open valve to allow water to escape.

Mechanical Hazards



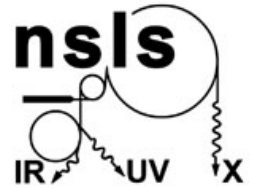
- Potential for hazards exists mainly when maintenance is being performed
 - Hoses; Poly-flow and Hytron (Orange) Hoses
 - Valves; Usually closed and/or capped
 - Caution Tags when lineup altered for bake outs
- Watch out for puddles
- System Relief Valves
 - Should be piped down and towards a floor drain

Mechanical Hazards



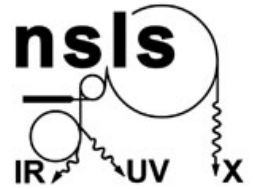
- Compressed Air system at 100 psig
Air supplied to solenoid valves which control front end valves, VAT Valves and Flags
- Relief valves may startle a person
- Fast valves, water cooled masks and shutters can be operated locally and remotely.
- Flags can be operated without warning.

Mechanical Hazards



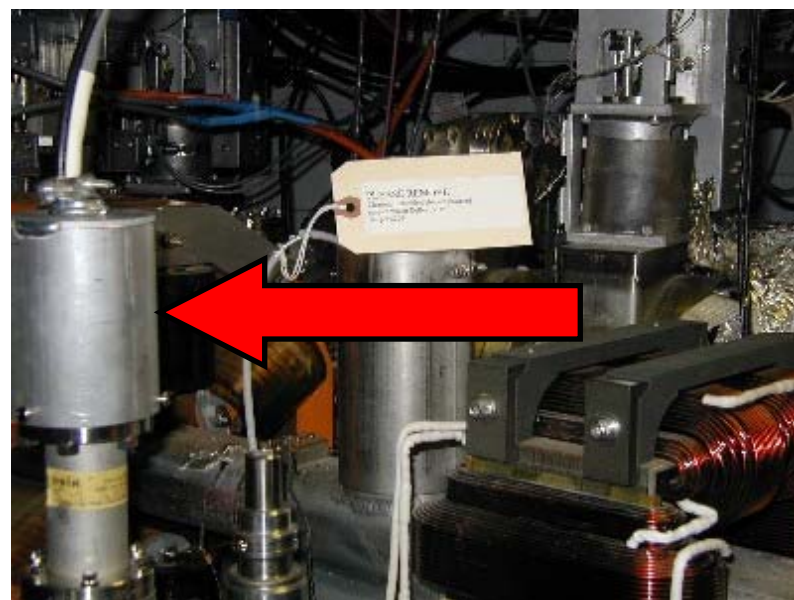
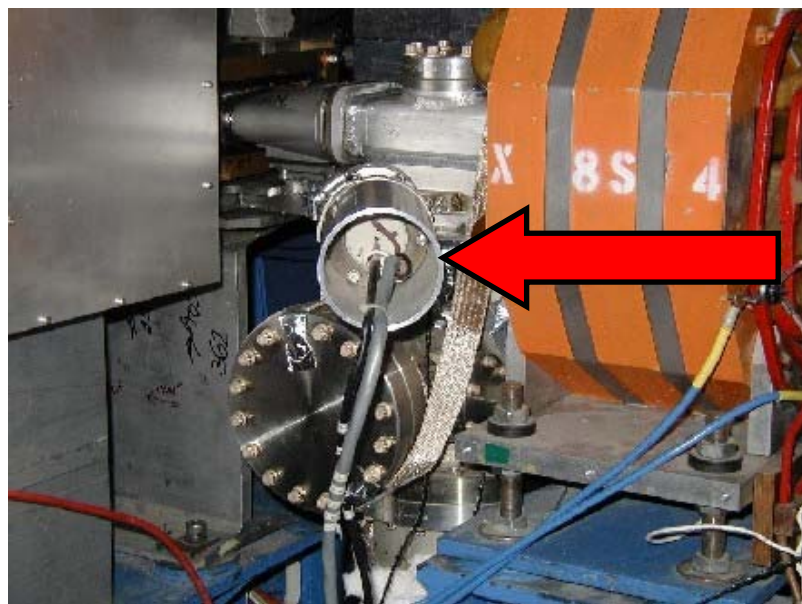
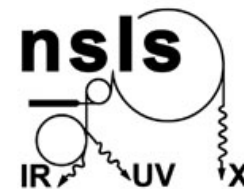
- X17 Helium and LN₂
 - Cryogenic fluids pose thermal hazards and oxygen deficiency hazards if sufficient liquid or gas escapes. These lines and components should not be dangerous but people should be aware of their presence.
- A 600psi gaseous nitrogen system is used inside the X-ray ring to actuate many vacuum valves. The GN₂ supply is located outside the X-ray ring, but some Granville Phillips Controllers are inside the ring near their associated access door.

Electrical Power to Vacuum Equipment

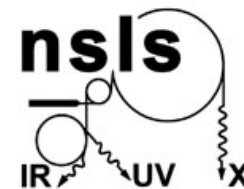


- Ion pumps are always on – 5500 V @ 5mA (except during bleed-up)
- Ion gauges are on @ 180VDC @ 10mA, 535VDC may be applied @ 50mA for cleaning gauges when needed (including when the ring is open)
- Convection gauges and thermocouples are in range A, but are also activated.
- Cold cathode gauges are on all the time, they run at 3500 VDC, 70mA max.
- Fast valves – sensors have 3500 VDC applied, current is limited to $\leq 50\text{mA}$.
- **No exposed voltages;** Contact appropriate personnel when working on or around equipment.

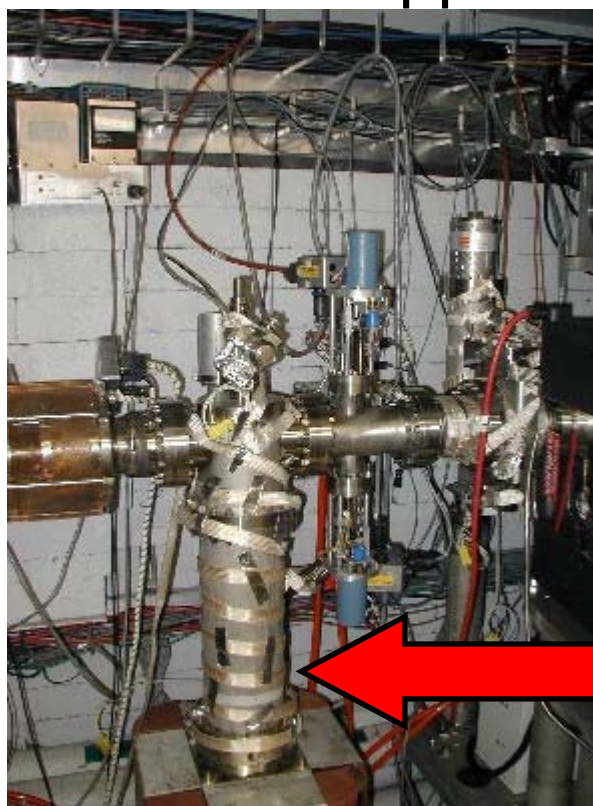
Ion Gauge Feed-throughs



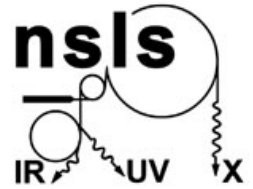
Ion Pumps



- Wires, hoses, heat tape, etc. are often all around Ion Pumps. This one is easily accessible. Many are buried under the blue iron support frames.

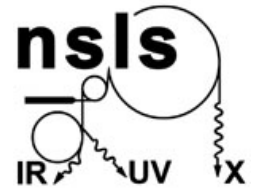


Movement Hazards



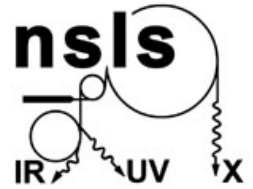
- Front end valves can be operated anytime
- Insertion device stepping motors may pose both an electrical and mechanical (pinching) hazard. Voltages and currents may vary according to the system.
- RF Cavity tuners can be moved, but are covered.
- Undulator and undulator driving mechanisms- clothing or extremities could get caught in the drive chains. The chains generally move very slowly, so movement may not be noticed. All necessary precautions should be taken however when working in close proximity.
- Should also be aware of magnetic field in these areas.

Climbing



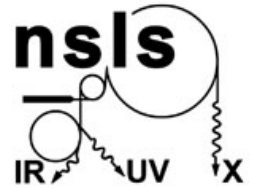
- All areas have similar hazards
 - Lead / Shielding
 - Wires
 - Hoses
 - Falling
 - Sharp edges
 - Clothing catch points
 - Trips, slips, falls

Sharp Edges



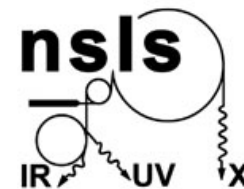
- Throughout the X-Ray tunnel there are many sharp edges and pointed objects. Know where you are especially when crawling and climbing.
- There are sharp edges that can bump heads, cut skin and tear clothes.

Slips, Trips and Falls



- Whenever water is present, during leak repairs, there is a slip hazard. Custodians can be contacted through the Building or Alternate Building Manager.
- Trip hazards often occur when climbing over the ring and positioning oneself to access hard to reach components. During shutdowns there may be multiple people/groups working in the area with their own tools which may clutter the aisle.
- Care should be taken during climbing to ensure your footing and minimize fall hazards.

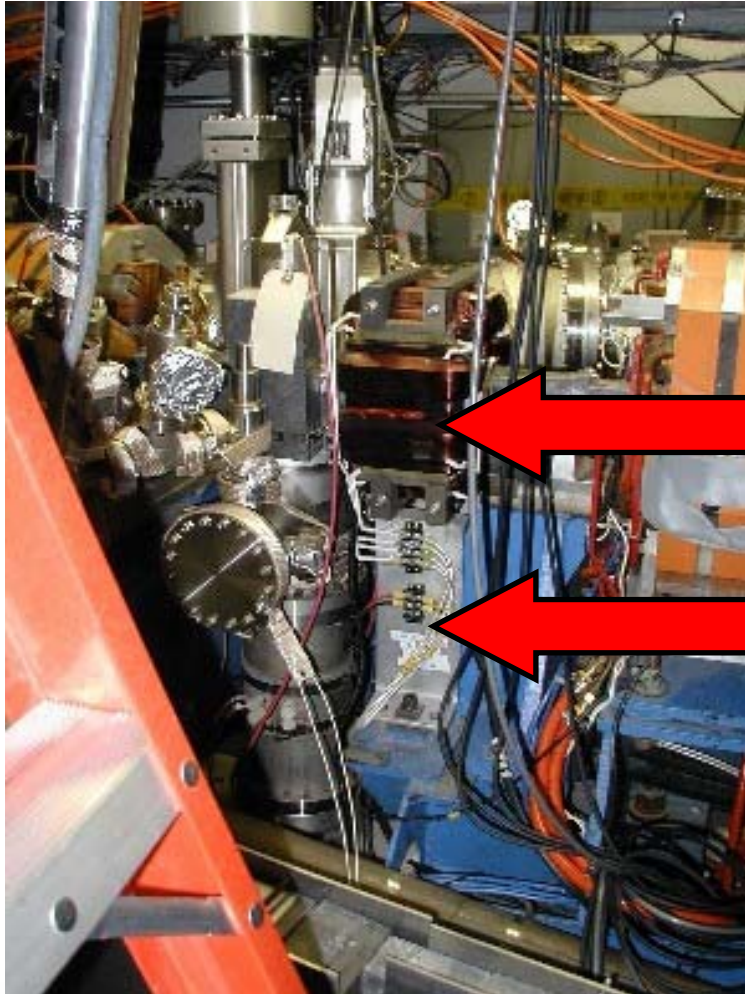
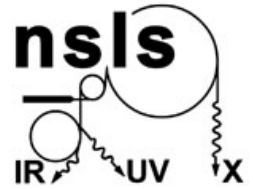
Electrical



- Assume all cables are above Range A, 50Volts or higher, until proven otherwise.
- Vacuum systems (*previously mentioned*)
- Wires throughout the ring (multiple colors);
 - Red high voltage
 - Black may be high or low voltage

Note –The appropriate NSLS staff member(s) should be consulted, and verification should be obtained to insure that all hazardous energy is disconnected and LOTO before proceeding with tasks whereby workers may come into contact with high voltage arc or shock hazards.

Electrical

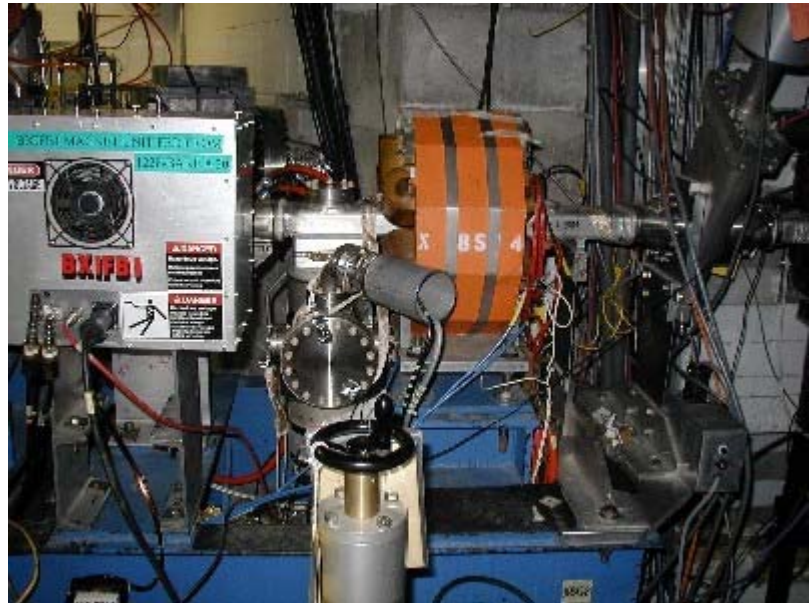
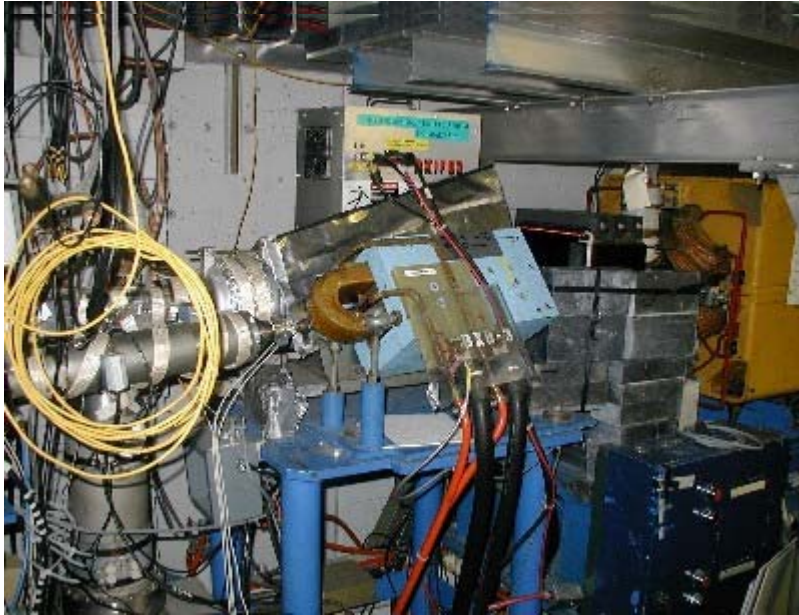
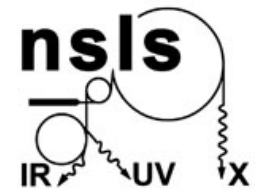


- Trim magnets and associated wires - range A

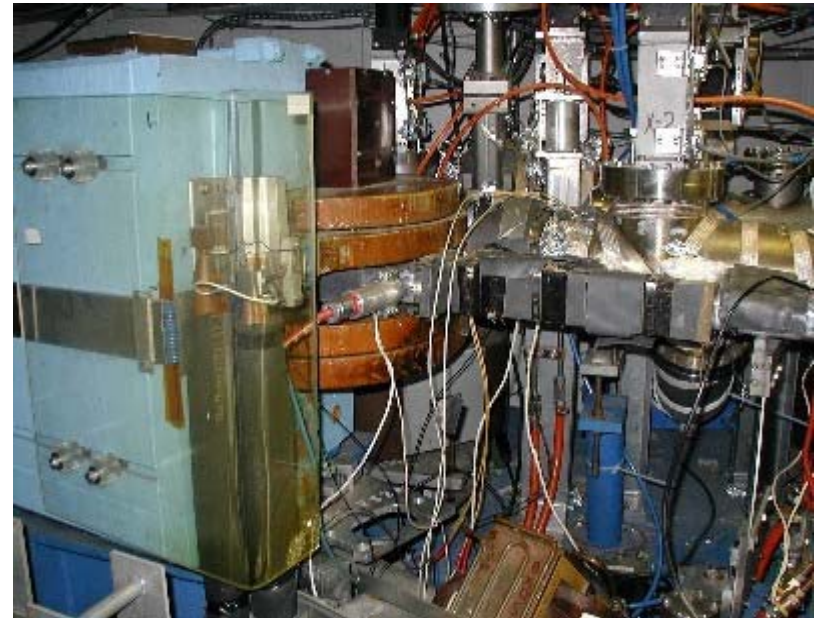
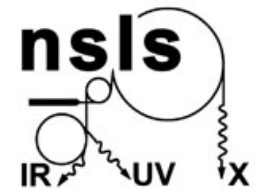
Trim magnet

Wires

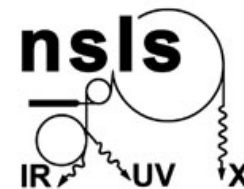
Wires in the X-Ray Ring



Wires in the X-Ray Ring

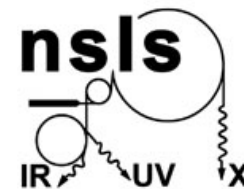


Power Systems



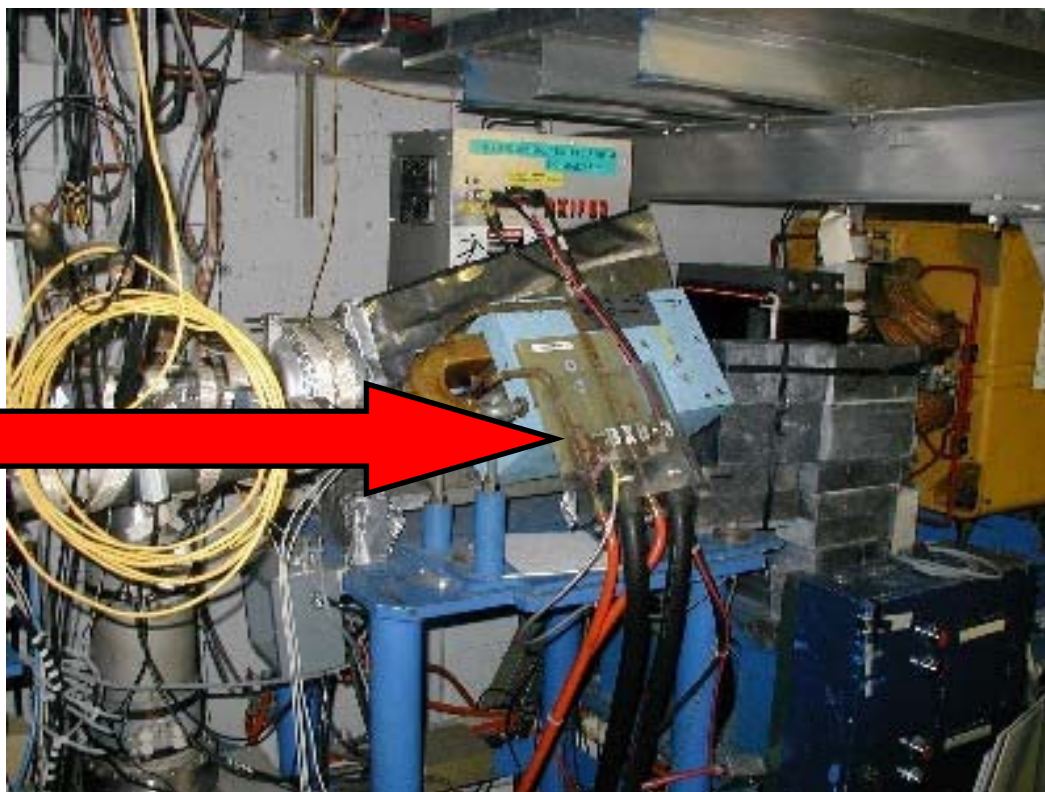
- When climbing be careful of wires, delicate equipment and Klixons.
- LOTO when entering for work as necessary to ensure equipment is de-energized.
- Kicker magnets require LOTO.
- Transport line has energized magnets and the connections should be covered by Lexan. This is more of an arc flash problem than a shock hazard.
 - BXD- ~30 volts and ~310 amps
 - BXD5- ~5 volts and ~250 amps
 - BXQ1- ~8 volts and ~200 amps
- Questions? Contact Power Systems Group.
- Only Qualified people should work on Power Systems equipment.

Power Systems

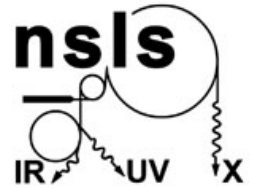


- Picture of magnet that may be energized on the transport line.

Covered Electrical
connections

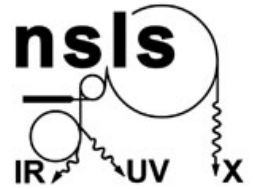


RF Systems

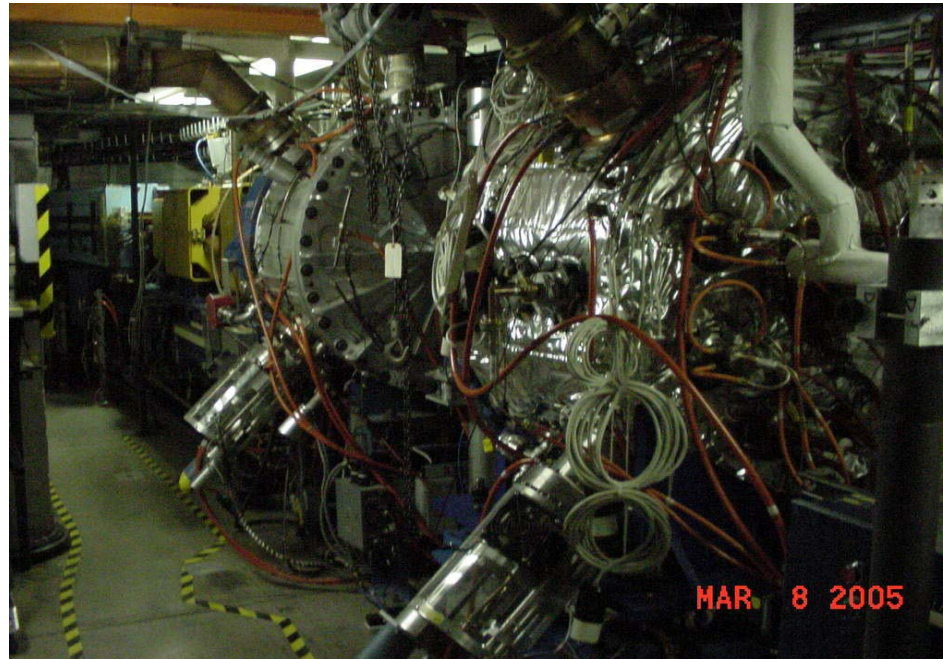


- Do not disconnect cables or piping, contact RF group.
- LOTO for Coax cables
- Coax looks like pipe, be sure you do not mistake it for piping.
- Coax is large, up to 6 inches, not the the smaller cable
- When in doubt, contact RF Group Supervisor to make it safe.
- RF heaters and pump may be running; Powered by 480 VAC
- Power supplies can be on.
- Only Qualified people should work on RF equipment.

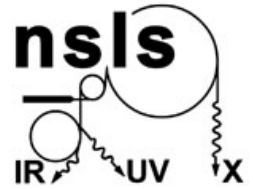
RF Systems



- When RF fields are present the gates surrounding the RF Cavities will be closed. Do not bypass these closed gates. Steer clear of the area.

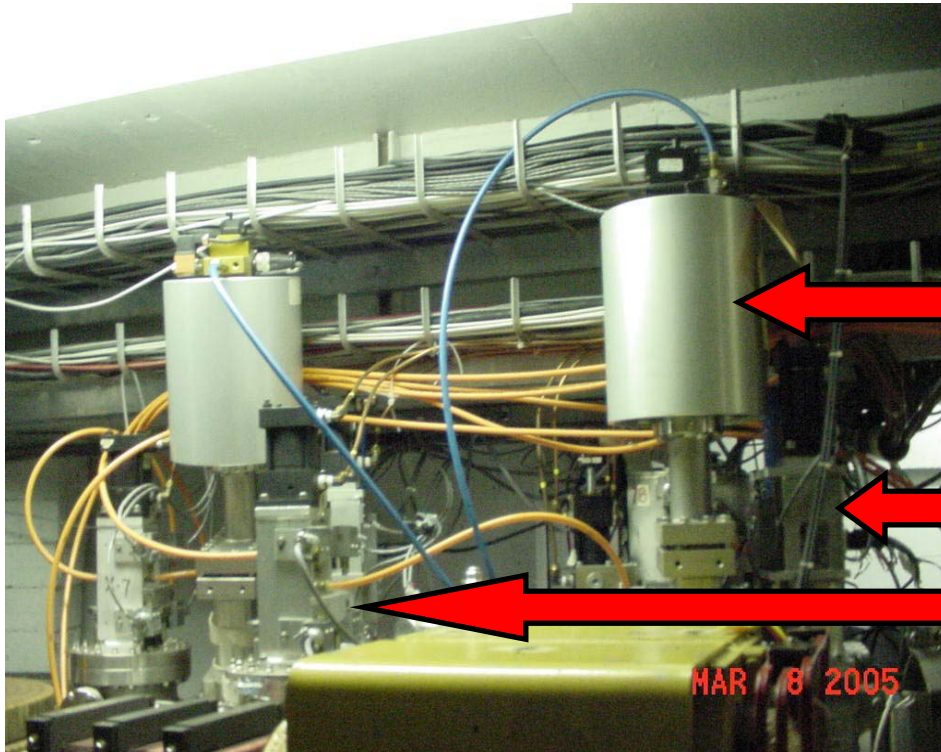
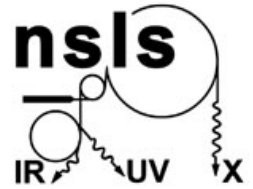


Interlocks



- Secure devices that move before working on them i.e. fast valves and shutters.
- Use LOTO and release the gas pressure that operates the valves.
- Fast valves are spring loaded and the trigger box is energized.
- Only qualified people should be working on this equipment.

Front End



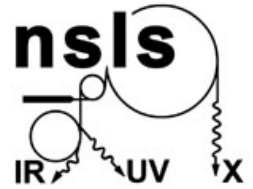
- Moving Valves, shutters not shown.

Vat Valve – sound of air

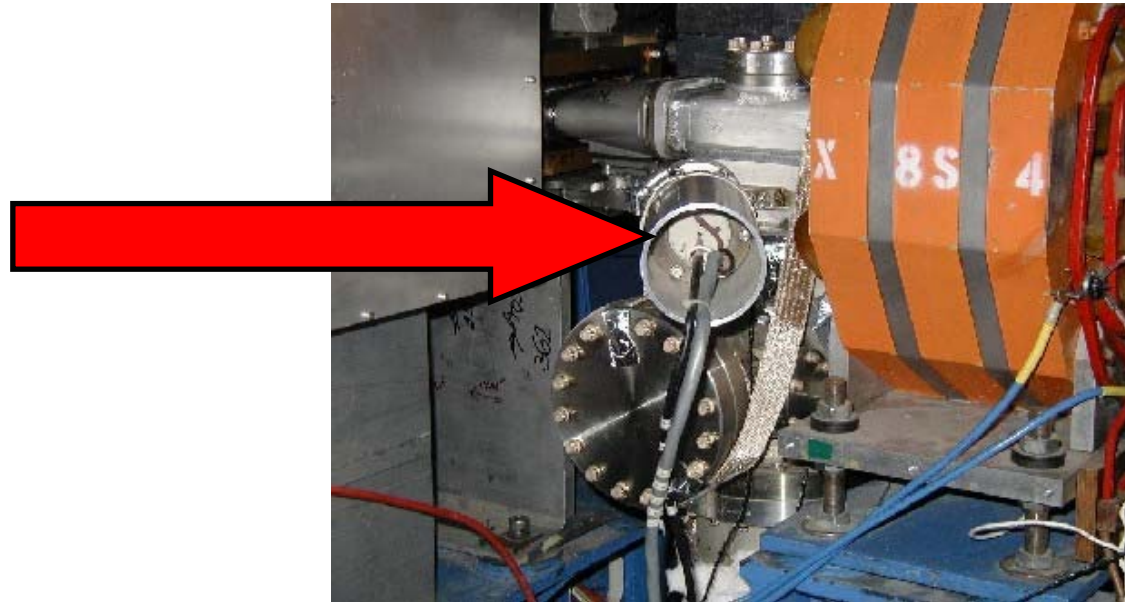
Fast Valve

Mask

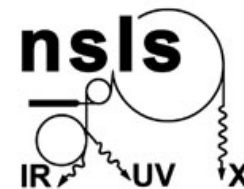
Temperature



- Bake-outs create high temperature, 120°C to 150°C, but areas are roped off and restricted access areas.
- Vacuum Gauge feed-through covers are usually warm to touch.

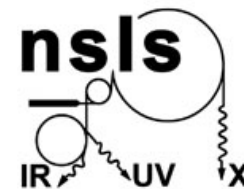


Magnetic Fields



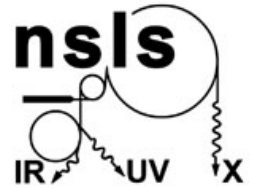
- Magnetism- Ion pumps and permanent magnet insertion devices can attract ferrous metal tools and other ferrous objects.
- Permanent magnets are a part of undulators and wigglers.
- All areas where a 5 Gauss or greater field is present should be labeled, and appropriate precautions should be adhered to.

Tunnel Search & Emergency Stops



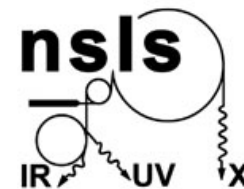
- **Upon Search & Secure of X-Ray Tunnel, personnel should leave the area immediately and/or make your presence known to the searchers** so that they may stop the search sequence (e.g. when working on the outboard side of the ring).
- **Press an Emergency Stop button if you are in the X-Ray Tunnel and you hear the audible warning search siren.**
 - Numerous Red Emergency Stop Switches are located around the tunnel on the inside wall at eye level.
 - Pressing an Emergency Stop will prevent the completion of a search sequence, turning on magnet power supplies, and opening of the x-ray injection shutter.

Conclusions



- Be aware of what is around you where you are working.
- Take no chances.
- Be careful when climbing
- Ensure that all work has been appropriately reviewed and screened before proceeding. Walk-downs are advised with appropriate supervisors
- Wear appropriate PPE as needed.
- STOP if you are unsure or have a question!

Course Credit



TO OBTAIN CREDIT FOR THIS COURSE:

When you have finished reviewing this material, please print out and sign the PDF file and send it to the NSLS Training Coordinator at mail stop 725D.

<http://www.nsls.bnl.gov/training/Requirements/x-ray-tun.pdf>